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INTERNAL COMBUSTION ENGINE

COMPONENT AND METHOD FOR THE PRODUCTION THEREOF

The invention concerns a component of an internal combustion engine of the type defined in greater detail in the pre-characterizing portion of Claim 1. The invention further concerns a process for production of a component of an internal combustion engine.

In components of internal combustion engines, such as, for example, cylinder heads or pistons, a problem frequently occurs during thermal cycling in that, in the case of prevention of thermal expansion in higher loaded areas, mechanical tensions are induced in these areas which are so high that, due to the strong plasticization and the therewith associated material fatigue in these areas, crack formation occurs. This prevention of thermal expansion occurs because the thermally higher loaded materials tend to more strongly expand than the thermally less loaded materials. Since the thermally higher loaded areas are generally in the middle of the component, an outwards expansion is not possible, and the result is the above mentioned tensions, in particular pressure tensions, which during the cooling process convert into contraction tensions, which can exceed the materials' strength.

To solve the problems, it has been attempted in accordance with the general state of the art to improve the casting technique and to employ a subsequent thermal treatment to produce a fine and stable-as-possible microstructure. These measures, however, extend evenly across the entire component, so that the above-described problems cannot be overcome by these measures.

It is thus the task of the present invention to provide a component of an internal combustion engine and a process for production thereof in which, even in the case of varying high thermal loads distributed across different areas of the component, the problems known from the state of the art with regard to the failure of the component can be avoided.

The problem is inventively solved by the characteristics set forth in Claim 1.

In accordance with the invention, the thermally highly loaded area of the component exhibits a lower thermal coefficient of expansion than the thermally less loaded area, which leads thereto, that the entire component can expand evenly during an increase in temperature. As a result thereof that the various areas of the inventive component expand evenly, there are smaller inhibitions in expansion, and thus smaller occurrence of the plastic deformation areas, so that upon heating and subsequent cooling essentially only small, or as the case may be, very minimal tensions are produced in the component, whereby the conventionally present danger of crack formation, attributable to the exceeding of the permissible tensions, is ultimately prevented.

By the inventive adaptation of the thermal coefficient of expansions to the thermal conditions within the component, the occurrence of a material fatiguing and/or a crack formation at a later point in time, or as the case may be, following higher loads, can be delayed, so that the inventive component can be employed in internal combustion engines with higher power and/or to lengthen the life span.

A process for production of an inventive component can be seen from the characteristics of Claim 9.

Therein the base material of the component is melted and an additive is introduced, which results in a changed thermal coefficient of expansion in the thermally higher loaded area. This manner of proceeding makes possible a particularly precise control of the alloy composition in the thermally higher loaded area.

Advantageous embodiments of the invention are indicated in the dependent claims. In the following, an illustrative example of invention will be described in principle on the basis of the figure.

There is shown in:

Fig. 1 a view of an inventive component in a first condition;

Fig. 2 a section through an intermediate area of the cylinder head according to the line II-II from Fig. 1 in a first condition;

Fig. 3 the intermediate area of the cylinder head from Fig. 2 in a second condition;

Fig. 4 the intermediate area of the cylinder head from Fig. 2 in a third condition;

Fig. 5 a view of the component from Fig. 1 in a second condition;

Fig. 6 a view of the component from Fig. 1 in a third condition;

Fig. 7 a view of a component according to the state of the art in a first condition;

Fig. 8 a view of a component according to Fig. 7 in a second condition; and

Fig. 9 a view of the component from Fig. 7 in a third condition.

Figs. 7, 8 and 9 show a component **1** of an internal combustion engine – not shown in its entirety – as known from the state of the art. The component **1** is in the present case a cylinder head **1a**, wherein Figs. 1, 5 and 6 show a view on the separating surface **2** of the cylinder head **1a**. In place of the cylinder head **1a** the component **1** could just as well be a piston or another thermally very strongly loaded component of an internal combustion engine.

The cylinder head **1a** includes multiple valve bores **3**, between which a thermally higher loaded area **4** is located, which in the following is referred to as the intermediate area **4a**. This intermediate area **4a** is, during operation of the internal combustion engine, higher thermally loaded than the rest of the component **1** or, as the case may be, than other areas **5** of the component **1**. Since the internal combustion engine associated with the cylinder head **1a** has three, or as the case may be, six cylinders, a total of three intermediate areas **4a** are provided. Since four valve bores **3** are provided for each cylinder, the intermediate areas **4a** essentially have a cross-shaped design. If two valve bores **3** were provided per cylinder, then the intermediate areas **2a** could also have a linear design. In the case of a piston, the thermally higher loaded area **4** would likely be the piston bowl. Of course, the number of cylinders in the internal combustion engine could be varied as desired.

If the component **1** is comprised in its entirety of a homogeneous material, preferably of an aluminum material, in particular, an aluminum-silicon alloy, it would exhibit a constant thermal co-efficient of expansion α_1. The temperature of the component **1** is, in the case of the not-heated condition as shown in Fig. 7, likewise at a constant level T_0.

Fig. 8 shows the component **1** in its heated condition. Therein there exists internally of the component **1**, namely in the thermally higher loaded area **4**, an elevated temperature T_2 in comparison to the lower temperature T_1 in the area **5**. Since the expansion of the thermally higher loaded area **4** is, however, prevented by the lower expansion of the area **5**, a plasticization of the area **4** results in the heated condition.

If, as shown in Fig. 9, the component **1** is cooled back to the temperature T_0, this leads to contraction tensions internally of the component **1**, in particular in the thermally higher loaded area **4**, which could ultimately lead to the formation of a crack as indicated by dashed lines. A formation of cracks can also occur in a - here not shown - spark plug bore or at a - likewise not shown - injection bore hole.

Figs. 1 through 6 show the component **1** according to the present invention. In order, in contrast to the above-described problem, to achieve an even expansion of the component **1** during the operation of the internal combustion engine, the thermally higher loaded area **4** exhibits a lower coefficient of expansion α_2 then the thermally less loaded area **5**, which also continues to exhibit a thermal coefficient of expansion α_1. The untreated condition of the component **1** is shown in Figs. 1 and 2.

In order to produce the component **1**, the higher loaded area **4** is melted, so that a melt pool **5** results, as shown in Fig. 3. This melting is preferably carried out using a beam process, and in particular using a laser beam **7**. As an alternative to employment of the laser beam **7** an electron beam or the like could be employed. Further, it would also be possible to produce the melt pool **6** by means of a WIG process or in another suitable mode and manner.

As shown in Fig. 4, an additive **8** is introduced into the melt pool **6**, which leads to the described reduction in the thermal coefficient of expansion α_1 of the component **1** to the valve α_2 for the higher loaded area **4**. Preferably, as the additive **8,** a ceramic material (in the form of powder or bristles; for example Al_2O_3) is employed. Further, the additive can be comprised of silicon or be in the form of an intra-metallic dispersion, for example on the basis of Al-Fe-Zr/Ce.

From the illustration according to Fig. 5 it can be seen that during the operation of the internal combustion engine, that is, during the relevant heating of the component **1** over the two areas **4** and **5,** despite the higher temperature T_2 of the thermally higher loaded area **4,** an even expansion is produced, since the material of the thermally higher loaded area **4** expands less strongly then the material of the thermally less loaded area **5** and thus is not hindered in its thermal expansion thereby.

Finally, Fig. 6 shows the condition after cooling of the component **1** and it can be seen that no formation of cracks is indicated.